JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2006, **39,** 243–247 NUMBER 2 (SUMMER 2006)

SOME EFFECTS OF STIMULANT MEDICATION ON RESPONSE ALLOCATION: A DOUBLE-BLIND ANALYSIS

MICHAEL E. KELLEY

MARCUS INSTITUTE AND EMORY UNIVERSITY SCHOOL OF MEDICINE

WAYNE W. FISHER

MARCUS AND KENNEDY KRIEGER INSTITUTES AND
JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

AND

JOANNA E. LOMAS AND ROY Q. SANDERS

MARCUS INSTITUTE

Children who are diagnosed with attention deficit hyperactivity disorder (or who engage in behavior consistent with such a diagnosis) are often prescribed stimulant medications for hyperactive or inattentive behaviors. However, the mechanisms by which stimulant medications affect individuals' behavior are rarely evaluated. The purpose of the current study was to evaluate the effects of stimulant medication on response allocation when antecedents and consequences were held constant and equated. Results indicated that the presence of an amphetamine medication (Adderall®) influenced response allocation across two concurrently available responses while all other stimulus conditions were held constant.

DESCRIPTORS: attention deficit hyperactivity disorder, developmental disabilities, response allocation, stimulant medication

---

Stimulant medications are often prescribed for individuals who are diagnosed with attention deficit hyperactivity disorder (ADHD) or who display behaviors that are consistent with such a diagnosis. Results of some studies have demonstrated that stimulant medications may affect responding by exerting influence on either the antecedent or consequence component of the three-term contingency (i.e., antecedent-behavior-consequence). For example, results of Northup et al. (1999) showed that the presence of an adult was a more effective discriminative stimulus for appropriate behavior when stimulant medication was present than during a placebo condition. Thus, the presence of stimulant medication appeared to affect the efficacy of a stimulus for occasioning behavior.

Results of a study conducted by Northup, Fusilier, Swanson, Roane, and Borrero (1997) showed another way in which stimulant medication may affect levels of behavior. They presented data suggesting that the presence of stimulant medication functioned as a motivating operation (Laraway, Snycerski, Michael, & Poling, 2003) that altered the reinforcing effectiveness of certain consequences. In the Northup et al. study, stimulant medication appeared (a) to decrease the reinforcement value of edible items and (b) to increase the reinforcement value of certain activities. Together, the results of these studies suggest that stimulant medications may influence behavior

This investigation was supported in part by Grant 5 R01 MH69739-02 from the National Institute of Mental Health.

Correspondence and requests for reprints should be sent to Wayne Fisher, Munroe-Meyer Institute, UNMC 985450, Nebraska Medical Center, Omaha, Nebraska 68198-5450 (e-mail: WFisher@UNMC.edu).

doi: 10.1901/jaba.2006.24-05

by altering the efficacy of either the antecedent or the consequence component of the three-term contingency.

Another potential way in which stimulant medications may affect behavior is by altering the manner in which an individual allocates responding among concurrently available response options. That is, most non-behavior-analytic studies on the behavioral effects of stimulant medications have found that these agents tend to increase certain responses (e.g., on-task behavior, academic performance) while at the same time decreasing other responses (e.g., activity level, disruptive behavior; Faraone & Biederman, 2002). It remains unclear whether stimulant medications directly alter the probabilities of certain responses, because the antecedent and consequent stimuli associated with the target response (e.g., on-task behavior, disruptive behavior) are rarely controlled or monitored in drug studies (with Northup et al., 1997, 1999, being notable exceptions). Thus, the purpose of this study was to evaluate the effects of stimulant medication on response allocation between compliance and destructive behavior when the antecedents and consequences for these two responses were held constant and equated.

METHOD

Participant, Setting, and Response Measurement and Reliability

Jake, an 11-year-old boy who had been diagnosed with moderate mental retardation and ADHD, participated in this study. His destructive behavior included aggression (hitting and kicking others), disruption (throwing and hitting objects), spitting (ejecting saliva from his mouth), and self-injurious behavior (face slapping). Compliance consisted of (a) initiation of the task within 5 s of a demand and (b) completion of the task. Jake's pediatrician had prescribed amphetamine medication (Adderall®) to attenuate hyperactivity and inattention both at school and at home. All sessions were conducted in a padded treatment room that measured 4.4 m by 5.3 m. Materials included tables, chairs, and other session-relevant materials.

Throughout both amphetamine and placebo sessions, a trained observer recorded frequency responses for destructive behavior and compliance. These measures were recorded on laptop computers though a one-way mirror. A second trained observer independently but simultaneously recorded these measures for 40% of sessions. Exact agreement coefficients were calculated by comparing observer agreement on the exact number of responses for each 10-s interval in the session. Agreement coefficients were calculated by dividing the number of intervals with agreements by the total number of intervals and multiplying by 100%. Agreement coefficients averaged 97% (range, 77% to 100%) for destructive behavior and 98% (range, 90% to 100%) for compliance.

Procedure

Preassessments. Jake received 20 mg of amphetamine at 9:00 a.m. each day during the preassessments. Preferred stimuli for all assessments were identified via a paired-choice preference assessment (Fisher et al., 1992). Results of an initial functional analysis (Iwata, Dorsey, Slifer, Bowman, & Richman, 1982/1994) indicated that Jake's destructive behavior was maintained in part by escape from demands and access to tangible items (e.g., video game). Subsequent treatment consisted of differential reinforcement of alternative behavior in the form of a simple response chain (fixed-ratio [FR] 1 FR 1) in which one compliant response produced a functional-communication-training card (FCT; Carr & Durand, 1985) that could be exchanged for a 20-s break from work with access to a video game. Data from these assessments are available from the corresponding author.

Medication evaluation. The purpose of this evaluation was to determine whether amphetamine, a stimulant medication, affected response allocation when both responses produced the same reinforcement under the same stimulus conditions. Thus, medication status (20 mg of Adderall® or placebo) was alternated in a double-blind fashion (i.e., only the school's nurse was aware of medication status) in a reversal design. Medication status (i.e., active or placebo) was randomly determined on the 1st day of the analysis and was subsequently alternated each day until the end of the analysis. Either amphetamine or placebo was administered at 9:00 a.m., and all sessions were conducted between 10:00 a.m. and 2:00 p.m. During each 10-min session, the therapist issued continuous demands. Two response options—destructive and appropriate behavior—were concurrently programmed to contact reinforcement during both drug and placebo conditions. Contingent on destructive behavior, the therapist terminated the demands and provided access to the video game for 20 s. Contingent on compliance, the therapist provided Jake with a communication card; contingent on a card exchange, the therapist terminated the demands and provided access to the video game for 20 s.

RESULTS AND DISCUSSION

Results of the medication assessment are depicted in Figure 1. Destructive behavior occurred at high levels (M = 5.5 responses per minute) when the placebo condition was in place. In contrast, low levels of destructive behavior (M = 0.04) occurred when amphetamine was active. Levels of compliance were higher when amphetamine was active (M = 1.3 responses per minute) than when placebo was present (M = 0.7). The percentages of reinforcers earned through destructive and appropriate behavior are depicted in the bottom panel. When amphetamine was in effect, 97% of the reinforcers Jake earned were for appropriate behavior and only 3% were for destructive behavior. In contrast, during placebo phases, only 57% of reinforcers earned were for appropriate behavior and 43% of reinforcers were received for destructive behavior.

The results of the current study showed that amphetamine affected response allocation. When amphetamine was active, Jake was much more likely to engage in compliance to obtain reinforcement than when placebo was in effect. That is, the presence of amphetamine biased responding toward appropriate behavior so that almost all occurrences of reinforcement were earned through this response. It should be noted, however, that high levels of destructive behavior and low levels of compliance occurred during the prior functional analysis while Jake was receiving the amphetamine. Thus, the behavioral treatment and amphetamine were both necessary to maintain low levels of destructive behavior and high levels of compliance.

From a theoretical perspective, these results are noteworthy because amphetamine had a direct effect on response allocation when both responses produced essentially the same reinforcement under the same stimulus conditions. Destructive behavior produced a 20-s break from work with access to a video game; compliance followed by FCT produced the same 20-s break from work with access to the video game. These results add to the literature by showing that stimulant medications can affect operant behavior via any component of the three-term contingency. From a clinical standpoint, stimulant medications may increase the probability of appropriate behavior, thus increasing its contact with reinforcement. Stimulant medications may be particularly helpful in situations in which differential reinforcement procedures are implemented without extinction or procedural integrity is less than optimal.

Future research should evaluate the effects of stimulant medication on response allocation between appropriate and problem behavior when the schedules for the two responses are manipulated parametrically using the principles of behavioral economics. Also, the current study

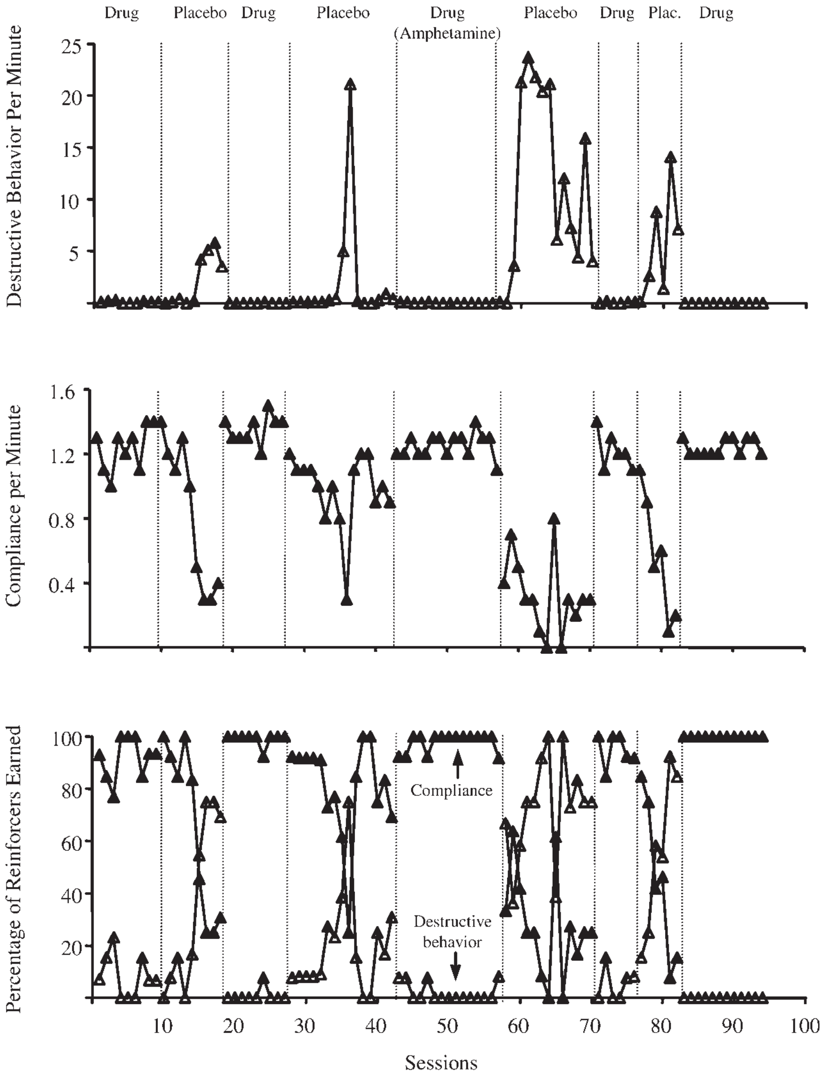

Figure 1. Responses per minute of destructive behavior (top), responses per minute of compliance (middle), and percentages of reinforcers earned via destructive behavior and compliance (bottom) during drug (amphetamine) and placebo conditions.

assessed one dosage level of one particular stimulant medication. Future research should assess the generality of these findings to other participants, other stimulant medications, and other dosages. Finally, future researchers may wish to evaluate specific response parameters that may be affected by the introduction of stimulant medication, such as response effort.

REFERENCES

Carr, E. G., & Durand, V. M. (1985). Reducing behavior problems through functional communication training. *Journal of Applied Behavior Analysis*, *18*, 111–126.

Faraone, S. V., & Biederman, J. (2002). Efficacy of Adderall for attention-deficit/hyperactivity disorder: A meta-analysis. *Journal of Attention Disorders*, *6*, 69–75.

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, *25*, 491–498.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*, *27*, 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2*, 3–20, 1982)

Laraway, S., Snycerski, S., Michael, J., & Poling, A. (2003). Motivating operations and terms to describe them: Some further refinements. *Journal of Applied Behavior Analysis*, *36*, 407–414.

Northup, J., Fusilier, I., Swanson, V., Huete, J., Bruce, T., Freeland, J., et al. (1999). Further analysis of the separate and interactive effects of methylphenidate and common classroom contingencies. *Journal of Applied Behavior Analysis*, *32*, 35–50.

Northup, J., Fusilier, I., Swanson, V., Roane, H., & Borrero, J. (1997). An evaluation of methylphenidate as a potential establishing operation for some common classroom reinforcers. *Journal of Applied Behavior Analysis*, *30*, 615–625.

Received February 28, 2005
Final acceptance January 20, 2006
Action Editor, John Northup